Monier Constructions.

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MONIER CONSTRUCTIONS.

By E. Lee Heidenreich,
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The system was invented some years ago by P. A. J. Monier, a gardener in Paris, who applied it in the making of water basins, cisterns, flower pots, etc. During the last ten years the Monier constructions have found applications in nearly all branches of engineering, civil and military constructions, in house building, highway and railway bridge construction, hydraulic mining, ship building, in permanent, as well as temporary fortifications, and last, but not least, in sanitary construction. It is a matter of surprise that this great building method of the future has not before come more prominently to the notice of the engineering fraternity of the United States. The system was patented in most European countries and through the energy of G. A. Wayss, the sole representative for Germany and neighboring countries, was most successfully exploited through prominent agencies in Dresden, Hamburg, Hanover, Cologne, Koenigsberg, Leipzig-Plagwitz, Witten a. R. and Copehagen, Denmark, all directed from their Central Technical Bureau at Berlin. Mr. Wayss has factories at Rixdorf, Koenigsberg, Leipzig-Plagwitz, Niedersachswerfen and Moscow, and in a cleverly executed and illustrated book by F. Rehbein, Royal Consulting Architect of Germany, dated Berlin, 1894, an astounding collection of remarkable constructions in all different branches in engineering has been collected with numerous descriptions and calculations of cost and

testimonials from the owners for whom the constructions have been executed.

Before mentioning any of the instances where Monier constructions have been applied with remarkable success, a short description will be given of the system itself.

The Monier construction consists of two materials, wrought iron or steel, and mortar, consisting of cement

FIG. 1

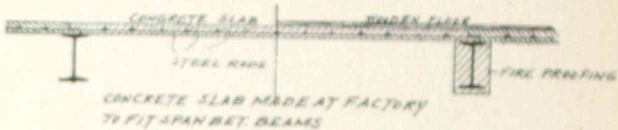


FIG. 2

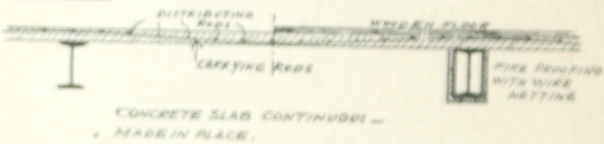
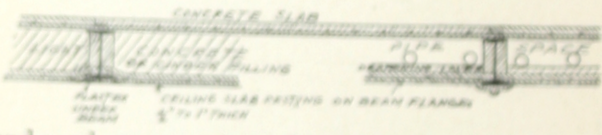


FIG. 3



and sand, or cement, sand and broken stone. The iron or steel is either in the form of rods or wires, and are designated as carrying rods and distributing rods. The first ones being quite heavy are calculated to take most of the tensile strain of the construction; the distributing

rods being lighter and serving the purpose merely to distribute evenly the load over the carrying rods. The two systems of rods are applied like a netting with meshes, varying according to the requirements of the construction, from say 2 ins. to 10 ins. square. In most cases the distributing rods are placed at a distance apart equal to about twice that of the carrying rods. After the iron skeleton is finished and the two systems of rods wired together every third or fourth crossing with about No. 18 annealed wire, it is placed on a false work

FIG. 4

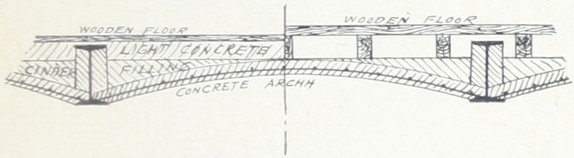
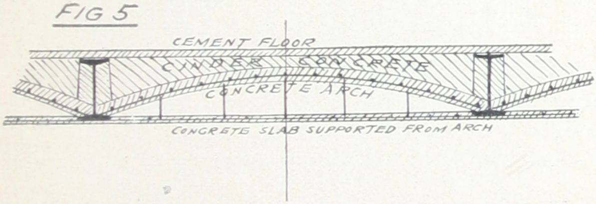


FIG 5



at a distance from the same, depending upon the thickness of the construction, and as a general rule one-sixth of the thickness of the plate from the side which is exposed to tension and is being kept up from the platform by small wooden wedges. Monier plates for floors or partitions may be either built in quantities at a central factory, or may be prepared on the building premises as hereinafter described. In the latter case

the modus operandi is as follows: Mortar, composed usually of one part best Portland cement and three parts sharp, clean, coarse sand, is then spread over the scaffolding and covering a wire netting, after being mixed with sufficient water to give a consistency similar to thawing snow, and then tamped until the water appears on the surface of the mass. If the plate is subjected to tension on both sides alternately, another layer of rods is put in and again covered with mortar

FIG. 6

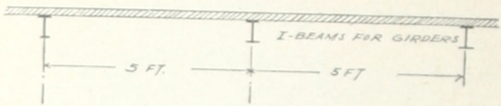


FIG. 6a

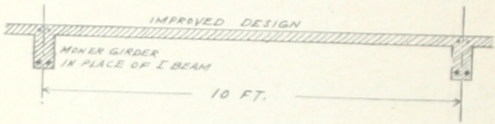
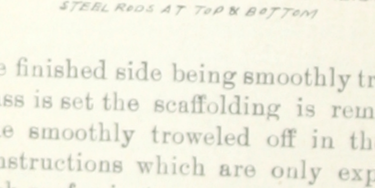


FIG. 7



CONCRETE ARCH BET. WALLS — LOAD UNEVEN.
STEEL RODS AT TOP & BOTTOM

LOAD = 1000 LBS PER SQ. FT
SPAN = 16'-6"
"B" = SPRING OF ARCH = 1'-7"
"A" = 9½"
CARRYING RODS = ¼" DIA
DISTR " = 3/16 "
DIST. BET. RODS = 2½"

the finished side being smoothly troweled off. After the mass is set the scaffolding is removed and the under side smoothly troweled off in the same manner. In constructions which are only exposed to compression such as, for instance, evenly loaded arches, the iron net is so applied as to give nearly the entire compression to the carrying rods, the concrete in this case serving two

purposes; first, to keep the carrying rods absolutely in their position so as to prevent any deflection in the same, and second, to take its part of the compression.

Where the plates have but little load, one cement to five or even six torpedo sand is quite sufficient.

Fig. 7.

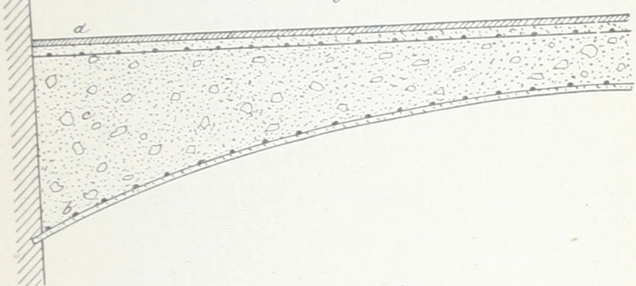
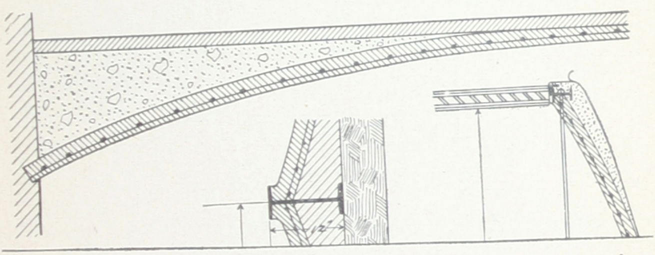


Fig 8



The most common objections to Monier construction have been:

First.—Oxidation of the iron in the cement.

Second.—The cement might not properly adhere to smooth iron rods, requiring an initial stress in the latter so as to make the concrete effective.

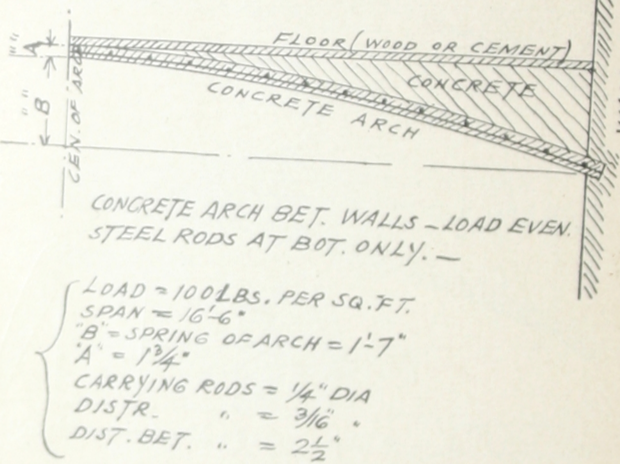
Third.—Difference in contraction and expansion during changes of temperature.

The above objections are answered as follows:

Ad. 1.—At Amiens, France, a pipe line built of Mon-

ier pipe was taken up after 13 years of use and at this time the rods were found as smooth as they were at the time of construction. At Breslau, in 1886, 12-year old Monier plates were broken and the rods found as smooth as new ones. Such parts of the rods as projected beyond the cement were oxidized almost to nothing, while the strength of the rods imbedded in the cement was not the slightest impaired. The reason for this seems to be that the air is absolutely excluded by the

FIG. 8



cement, as same, while stiffening chemically binds the water, thereby preventing the iron from absorbing its oxygen. Besides it appears that a thin layer of cement adheres to every iron rod, forming some silica connection to the same. This has been demonstrated for the past fifteen years in the construction of heavy foundations for buildings in Chicago.

Ad. 2.—If the cement did not adhere to the rods,

these two materials could not co-work as they do. The iron net would not only add to the carrying capacity, but would be detrimental to the same. At an experiment in Breslau, in 1886, an attempt was made to pull a $\frac{1}{4}$ in. rod out of a Monier plate 12 years old, but it was impossible, the end sticking out of the cement broke and pulled off at a strain of 2,860 pounds. The well known German Professor Bauschinger gives the adhesion be-

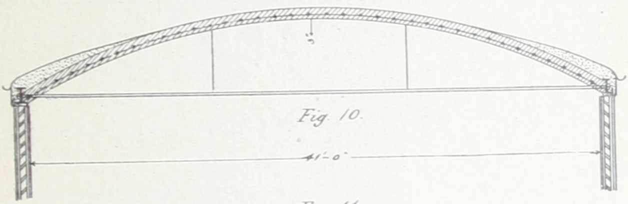


Fig. 10.

Fig. 11.

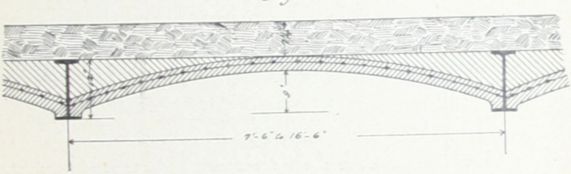
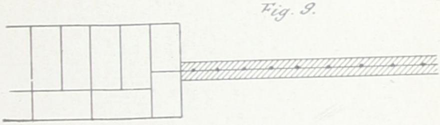


Fig. 9.



tween iron and cement at 625 lbs. per. sq. in. At an experiment in Berlin, 1886, the strength of two cement plates of $1\frac{3}{4}$ in. thickness 3 ft. square was compared. One of the plates had an iron net $\frac{1}{4}$ in. thick carrying rods, the other had none. The latter broke at 1.140 lbs., evenly distributed load, while the Monier plate sustained 6,100 lbs., deflecting $\frac{1}{2}$ in. under this load which caused the cement to crack, while the net still carried the entire load. The writer has made numerous

experiments here in Chicago to the same effect, proving definitely that the cement does adhere to the rods.

Ad. 3.—The co-efficient of expansion for one degree Celsius is for wrought iron 0.0000145, and for cement an average of 0.0000143, the difference being so insignificant as to have no influence whatever in common building construction. The writer has subjected Monier plates of 2 in. thickness, one foot wide, three feet long, to a temperature of 1,200 degrees Fahr., and immediately afterwards cooled them off by water without, to any appearance, changing the construction. This result could not have been obtained if the difference in the co-efficient of expansion had been sufficiently pronounced.

At a fire in Helbing's distillery at Wandsbeck, by Hamburg, December 21st, 1889, a $1\frac{3}{4}$ in. thick Monier plate in top story of the building prevented the fire from reaching the spirits and liquors stored on the floor below. The entire roof construction was wood, and burned, rafters and purlins falling down on the Monier floor, and although this was flooded with cold water it had no apparent effect on the floor afterwards.

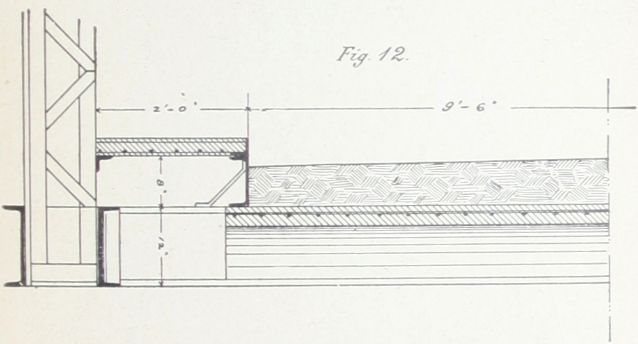
The following incidents may be of interest, and will serve to prove the efficiency of the Monier construction in a number of instances:

First.—A 12 ft. long, $7\frac{1}{4}$ foot high and $1\frac{3}{8}$ inch thick Monier partition was loaded with 22,000 lbs., without deflecting to either side or vertically. The carrying rods in this wall were 7-32 ins., and the mesh $2\frac{1}{2}$ ins. The carrying rods were slightly arched vertically instead of lying horizontally. The distributing rods ran vertically.

Second.—In May, 1890, the following experiment took place on the Matzleindorfer Railway Station, near

Vienna. An arched bridge built of Monier construction and finished the 18th of October, 1889, had 30 feet span, the center ordinate, or height of the arch being 3 feet, had a thickness in the center of $5\frac{3}{4}$ ins., and at the skew-backs, $7\frac{3}{4}$ ins. The bridge was 12 ft. wide and was subjected to a movable load of heavy freight cars and locomotives, which were slowly pushed across the span, and afterwards a permanent load consisting of rails piled up on one-half of the bridge. At a load on the one half of the span, amounting to 432,000 lbs.,

Fig. 12.

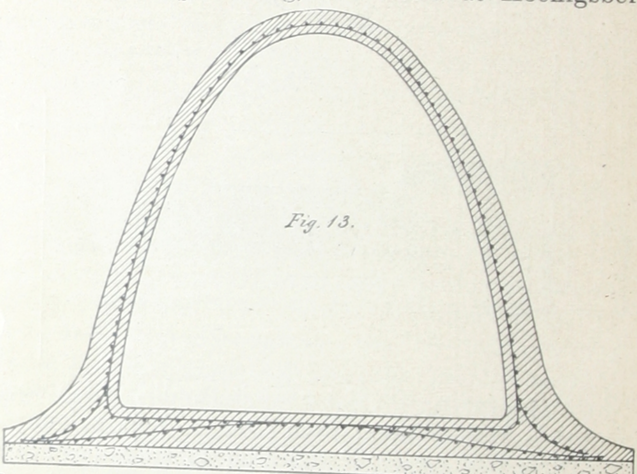


or 2,400 lbs. per sq. ft., the retaining walls, which were 9 ft. thick, were pressed from 1 in. to $1\frac{1}{2}$ in. sideways, permitting the center of the arch to sink down to a scaffold erected for the purpose, at the same time a crack appeared through the arch about 18 inches from the center and in the part that was not loaded. Of course the capacity of resistance was then entirely exhausted.

Third.—The 14th of November, 1890, a highway bridge at Wildegg, Switzerland, was tested as follows: The span is 117 ft., center ordinate 10 ft. 6 ins., thickness of the arch at the top $6\frac{1}{2}$ ins. and at the skew-backs

$9\frac{3}{4}$ ins. One-half of the bridge was first loaded with 40,000 lbs., or about 75 lbs. per sq. ft. without any result whatever. Afterwards a wagon loaded with three tons, pulled by four horses, traversed the bridge without any apparent effect on the same. This proved conclusively that the bridge was strong enough to withstand the movable pressure of a crowd which was the greatest load expected.

Fourth.—The 20th of April, 1888, a 6 ft. diameter Monier pipe, $4\frac{1}{2}$ ft. long, was tested at Koenigsberg,



Prussia. The pipe contained two nets, one at the inner and one at the outer surface and was loaded first, with 2,350 lbs. per sq. ft. The result was that the diameter was a quarter of an inch less vertically, increasing one-quarter of an inch horizontally. At a load of 3,150 lbs. per sq. ft. the changes were, respectively, $\frac{1}{2}$ in. vertically and horizontally. At the heaviest load of 5,250 lbs. per. sq. ft., the compression amounted to $2\frac{3}{8}$ ins. vertically with a corresponding elongation of the diam-

eter horizontally. Removing this load it was found that the pipe had received a permanent set of $1\frac{3}{4}$ in. and the pipe had a number of fine cracks extending from the surface to the center of the cement mass.

Fifth.—The following experiment shows the efficiency of Monier constructions as fire proofing material: On the 20th of November, 1886, experiments were made near Cologne, with two different kinds of floor construction in a building erected for the purpose. They were both arches of 13 ft. span, and 10 in. center ordinate. The one was of corrugated iron covered with concrete, the other was a Monier arch of

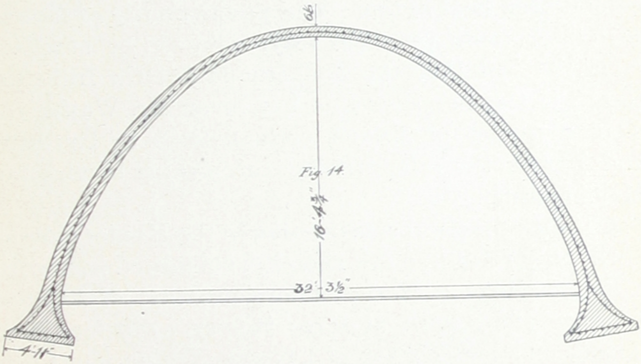


Fig. 14.

$1\frac{3}{4}$ in. thickness in the center. The load on both of them was a hundred pounds to the sq. ft. Under both arches was built a fire about 30 ins. below the skew-backs. As a result the corrugated iron became red hot and the entire arch dropped down in less than 20 minutes; while the Monier construction showed no change, although the fire was maintained considerably longer, the arch was cooled off very suddenly with water.

Resistance against blows.—A 45 lb. iron weight was dropped 5 ft. on a 2 in. thick Monier plate lying across a

3 ft. span. The weight recoiled twice from the plate without harming the latter in any way. The third time the weight was thrown from the same height a circular bump about 6 ins. in diameter was formed on the under side; the fourth time the cement fell from this bump and a hole remained in the plate, $1\frac{1}{4}$ in. x $2\frac{3}{4}$ in., otherwise the plate was unchanged as to carrying capacity.

A great many experiments have been made in Austria, Germany, Denmark and France, using Monier constructions as temporary and permanent fortifications, but the result of these experiments have, to a great extent, been kept secret. The practicability of Monier plates for these purposes may, however, be surmised from the fact that the Emperor of Austria from the results of these experiments has given Mr. Wayss, the main promoter of Monier constructions in Germany and Austria, the sole privilege of making bomb proof Monier vaults.

As to the practical construction in the Monier system, I will only refer to a few sketches submitted herewith:

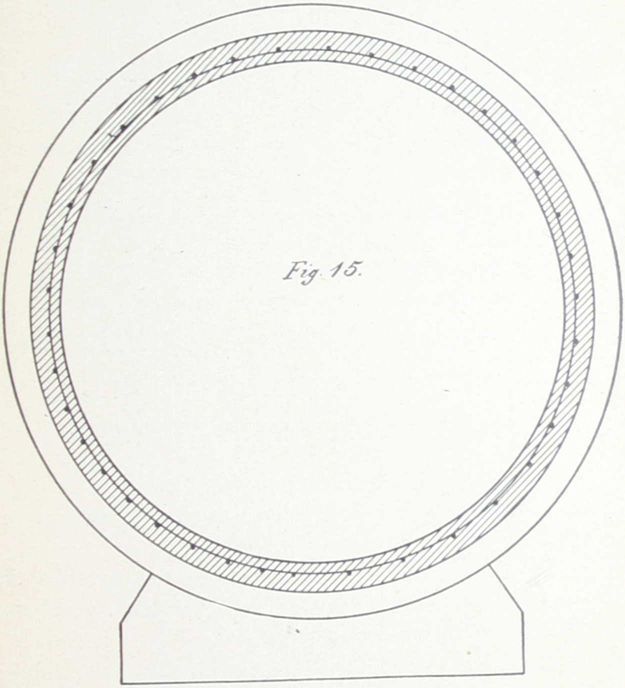
Fig. 1 shows a Monier floor consisting of fortified concrete slabs built at some factory, as before mentioned, and laid on top of I beams, having joints lapping and cemented. In the top layer in the manufacture of the Monier plates are left wooden strips to receive the nailings from the floor.

Fig. 2 shows the same construction but with the difference that the floor is made at the building and is continuous. It will be noticed that in this case the carrying rods between the supports are located one-sixth the thickness of the plate from the under side of the same, and at the supports the same distance from the top of the same.

Fig. 3 shows instances of using the Monier plates for floor and ceiling, using the space between them for deafening, leaving pipe space, etc.

Figs. 4 and 5 explain themselves.

Figs. 6 and 6a show the difference between Monier constructions in France ten years ago and to-day. In



place of using I beams between the girders they simply lay heavy rods to take the compression and tension of the I beams solidly imbedding these rods in cement and placing the distributing rods vertically in the usual manner. This design is exceedingly interesting, particularly at the present time when there is such a clamor

for iron and steel beams and when their price is almost prohibitive.

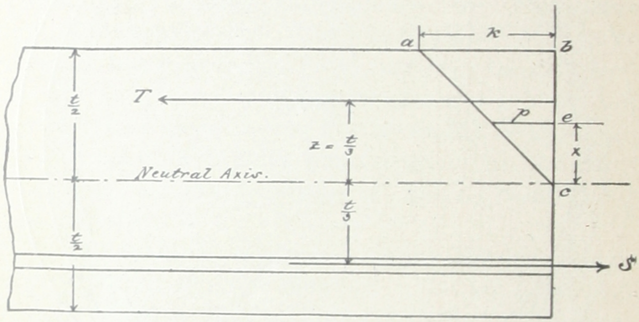
Figs. 7 and 8 give instances of vault and cistern roof constructions and arches in general.

Fig. 9 shows a vertical Monier partition as compared with a brick wall, plainly showing the saving of space.

Fig. 10 is interesting from the fact that a 41 ft. span has but a 3 in. thick Monier roof.

Figs. 11 and 12 show the Monier constructions as usually used in the bridges.

Fig. 16.



Figs. 13 and 14 show different sizes of culvert construction.

Fig. 15 shows plain pipe as made in factories in lengths from 5 ft. up. Some of the photos submitted further explain this construction.

Fig. 16 alludes to the calculations of Monier plates.

A deduction through well known formulas plainly proves that the resultants of compression and tension, respectively, are located $\frac{1}{3}$ of the thickness of the plate from the neutral axis, or in other words, one-sixth of the thickness of the plate from the most strained fiber, which is of course located on the two surfaces. The

thickness of the Monier plate, its carrying rods and the distances at which the latter are placed are calculated by the following simple formula which are easily deduced:

t equals thickness of concrete in inches.

a equals total square inches of steel carrying rods in 12 in. width of plate.

p equals load per square foot evenly distributed.

l equals length of span in feet.

t equals one-fortieth l multiplied by the square root of 3 p., allowing tensile strain on steel rods of 20,000 lbs. per sq. in., allowing compression strain on concrete of 400 lbs. per sq. in.

a equals 0.06 t; or, if only 16,000 lbs. is allowed per sq. in. of of steel, a equals 0.075 t.

The distributing rods are generally located at a distance apart equal to from one to three times the distance between the carrying rods. Distance between carrying rods equals twelve times their diameter.

APPLICATION OF THE MONIER SYSTEM IN CONSTRUCTING TANKS AND ELEVATORS.

Ever since 1892, have large grain elevators been in operation on the Danube River at Galatz and Braila in Roumania. These elevators were built entirely on the Monier system, but the cells were made hexagon and built in plates about 3 feet square, manufactured on the ground and afterward erected, same as one to-day might put up an elevator built of tile construction. Since that time, I have experimented considerably with circular tanks built in one monolithic mass, built on the premises for the purpose of storing liquids or grains and the experiments have proved satisfactory. It is a matter of surprise that the system, which has been declared by prominent European engineers, to open a new era in engineering, has gained but very little progress in the United States. At the present time when there is a very pronounced clamor for fireproof construction in grain elevators, and when the prices and scarcity of steel plates have made the construction of steel tanks nearly impossible, it seems that the proper time has arrived to give the Monier construction, so successfully used abroad, at least a trial. Before discussing the most economical methods of construction in cement and steel, I shall mention a few of the elevator projects abroad, planned and built directly under the Monier patents and designed and calculated by the most prominent engineers in Europe. The elevators at Galatz and Braila I have already mentioned. Professor Herman O. Shlawe of the Ministry of Agriculture of Roumania, under whose supervision these

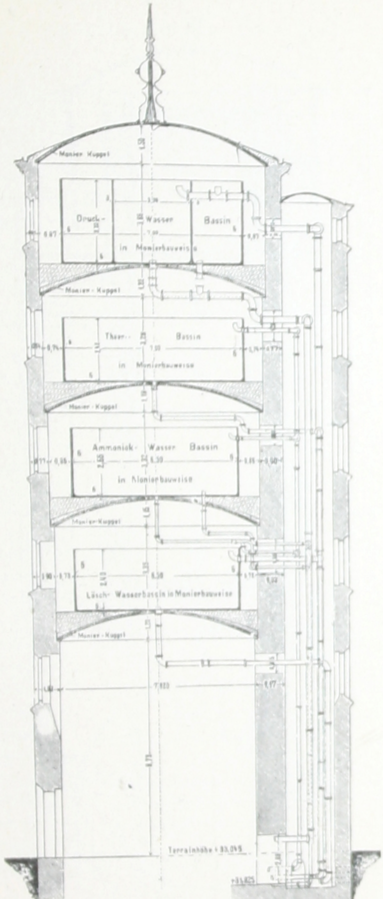


Fig. 1. Monier Reservoir for Gas and Liquids.

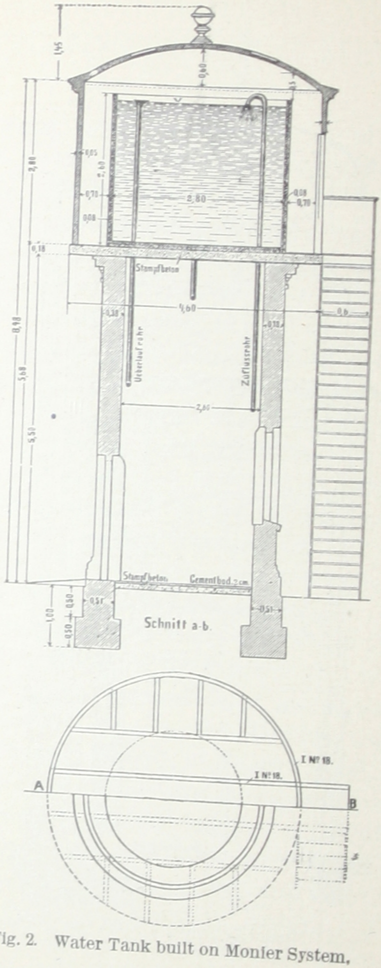


Fig. 2. Water Tank built on Monier System.

elevators were erected, has since written me expressing his entire satisfaction with the construction and the excellent qualities of concrete fortified by steel rods

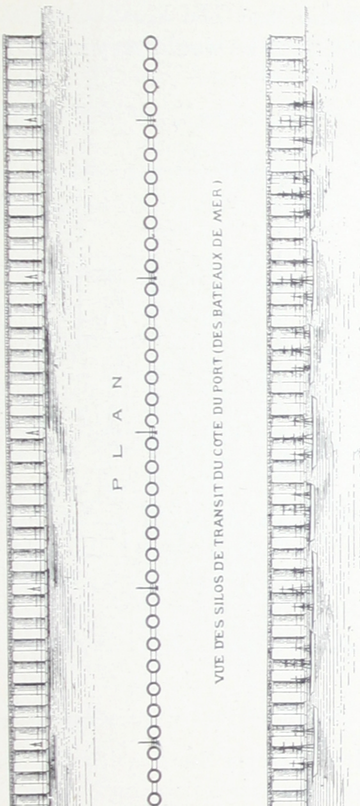


Fig. 3. Construction of Elevators on Monier System.

and as receptacles for grain. From Mr. H. C. V. Moeller, harbor master at Copenhagen, Denmark, I quite recently received a letter praising the Monier bin

walls used in the elevator for the Copenhagen Free Harbor. Owing to the expense, however, only the exterior bin walls are built in Monier construction; the interior being wood, but Mr. Moeller asserts that but for financial objections he would very much have wished

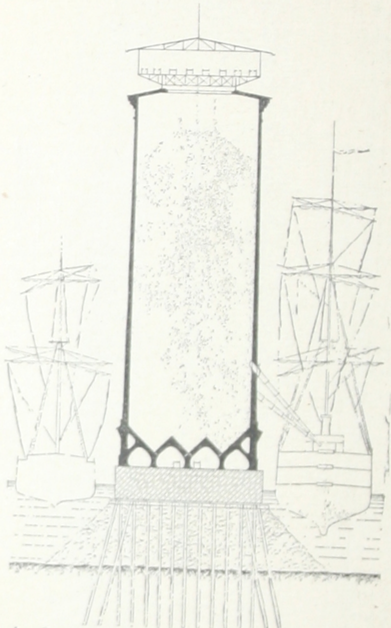


Fig. 4. Grain Storage Plant built on Monier System.

to see the entire elevator built with bin walls in the Monier construction.

Monier reservoirs are being used in Germany as receptacles for water, gas and liquids. For instance, the city of Charlottenburg, Germany, has constructed a series of reservoirs in its new gas works. They are about 22 ft. in diameter and 10 ft. high. (See Fig. 1.)

Two reservoirs containing water, another tar and another ammonia water. The range in thickness of walls from $2\frac{3}{8}$ inches to less than two inches, and have remained absolutely waterproof since 1893 when they were built. At the railway station in Dresden, Germany, there is a station water tank 9 ft. in diameter and 9 feet high, built in Monier construction with $3\frac{1}{8}$ in. thick walls. (Fig. 2.)

The well known German contractor, G. Luther, who, by the way, furnished the machinery for the elevators

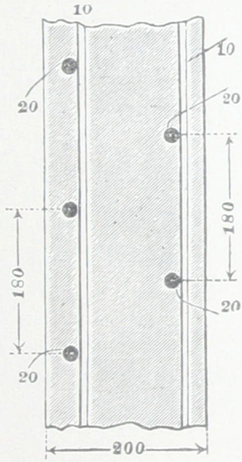


Fig. 5. Vertical Section of Wall built on Monier System.

at Galatz and Braila, wrote a pamphlet in 1889, "La Transformation du Port d'Odessa," reporting on the best construction for a large grain elevator plant at Odessa, Russia. After comparing the different methods of construction materials, he selected the Monier construction as the most economical, safe and practical solution of the question. In this very clever report,

which is profusely illustrated, all calculations are carried out to the minute details. Mr. Luther compares wood construction with steel, brick, and finally as before stated, gives the preference to the Monier construction. He decided to build his tanks 50 ft. in diameter and 140 ft. high. (See Figs. 3 and 4.) The bin walls being about 8 inches thick at the bottom, fortified by two nets of horizontal and vertical steel rods, the meshes being 7 inches square at the bottom and the heaviest rods in the construction being $\frac{3}{4}$ inch for hori-

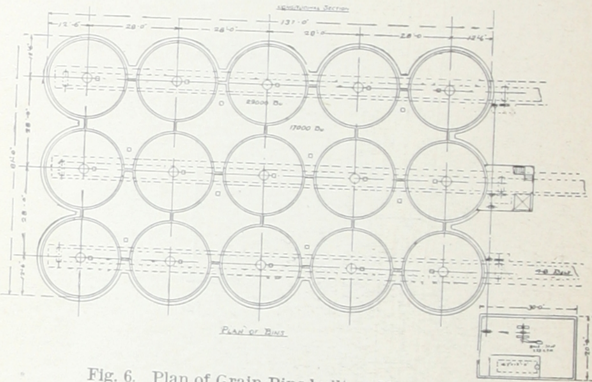


Fig. 6. Plan of Grain Bins built on Monier System.

zontal and $\frac{3}{8}$ for the vertical. In Fig. 5 is shown a vertical section.

On the basis of these constructions, many of which have been successfully operated for a number of years, I have made a number of designs for batteries of cylindrical reservoirs, so arranged as to make the entire series of bins one monolithic mass, the skeleton of which is a series of steel wire nets so interlaced as to meet the tension and compression strains produced by filling, not only the circular bins with grain, but the

spaces between the bins. These designs I have submitted to a number of grain elevator operators throughout the country, and had the construction and arrangement approved, but have always been met with doubts as to the strength, durability, tightness, absence of cracks, etc., all of which doubts have been proved groundless by practical experience abroad. Besides experiments made by the writer in this country have shown that structures erected according to the Monier system have all of these desirable characteristics.

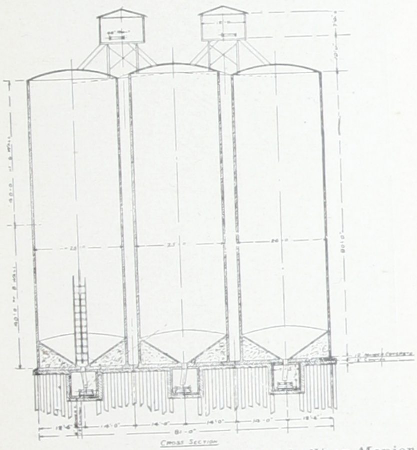


Fig. 7. Cross Section of Grain Storage Plant built on Monier System.

Whether cylindrical reservoirs be placed on rectangular lines as shown in figure 6 or on diagonal lines crowding the cylinders or reservoirs into a minimum of space the design maintains its principal advantage, that of having vertical walls or connections between the tanks acting as webs, ribs or strengtheners to the entire construction, enabling us to consider the building with its foundation walls and roof as one colossal

beam or girder in which the strain on individual parts is successfully transferred to the surrounding walls. Monolithic construction of this kind, casting as it were all the bins and their connections simultaneously in one mold, is a decided departure in building construc-

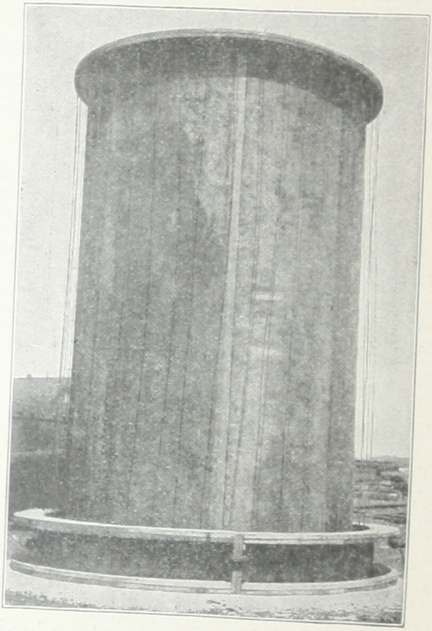


Fig. 8. Monier Construction.

tion, and was at first considerably criticised by engineers on the ground that expansion and contraction horizontally might cause cracks to appear in the construction. No such trouble has, however, occurred in the Monier construction in Roumania, Germany or Denmark, probably for the same reason that no trouble

has occurred from the continuous welded rail system, which was at first decried in a most lamentable fashion on account of the destructive results expected from expansion of the rails.

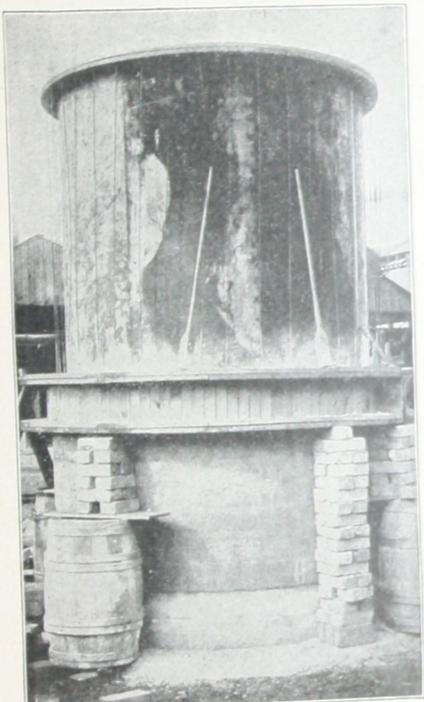


Fig. 9. Monier Construction.

The methods of calculating the thickness of bin walls in the Monier construction are extremely simple, the only question being a somewhat vague idea as to the component part of the grain weight contained in

a bin asserting itself on the side of the bin when the grain is in repose and in motion. A German engineer, Mr. Prante, has made very extensive experiments, in this connection and particularly for cylindrical

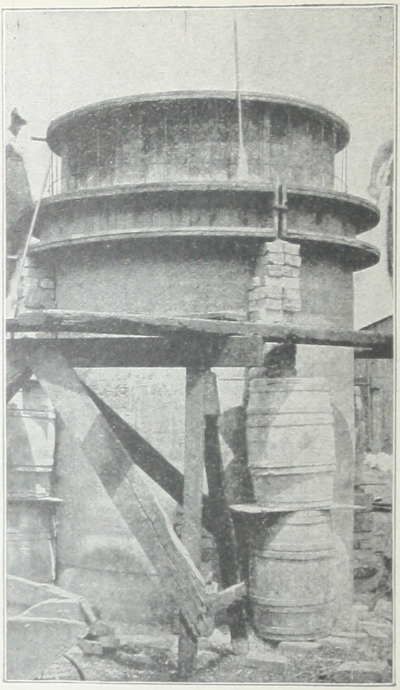


Fig. 10. Building Concrete Tank, Monier Construction.

reservoirs. The writer has made some experiments, and so have other American elevator builders, from which I have found that Mr. Prante's diagrams for the pressure on the bin will represent the maximum stresses on the walls, and I have made them the basis for my cal-

culations. These calculations have since been submitted to criticism by prominent American engineers, and they have been unanimously approved. As before mentioned, the Monier construction is protected by United States patent, and for the further protection of the same

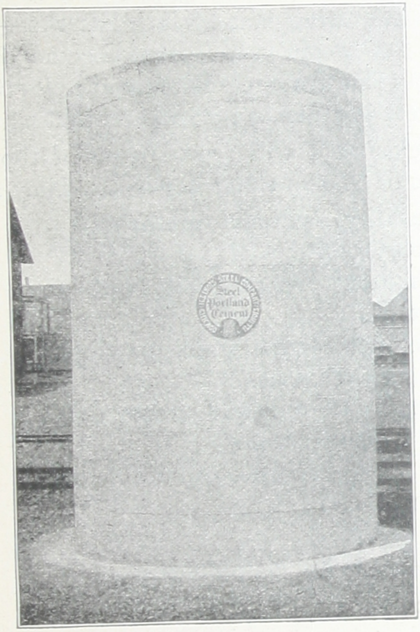


Fig. 11. Finished Concrête Tank, Monier Construction.

for storage reservoirs and incidental details, applications for other patents have been made by the writer and are now pending.

The views shown in Figs. 6 and 7 practically explain themselves. The center tower consisting of angle irons and bar iron ladders serves the double purpose of center

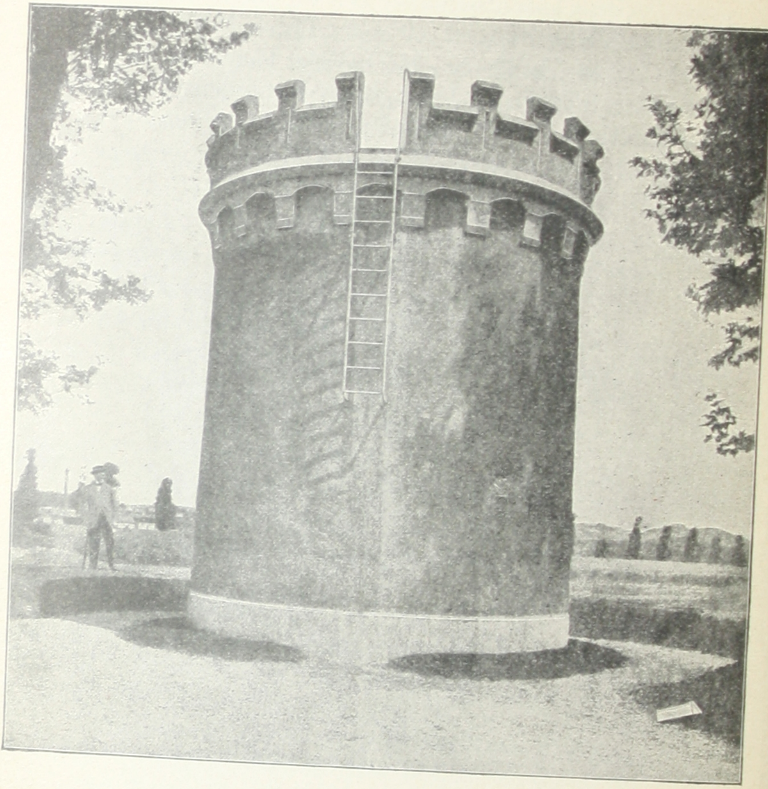
pole for supporting the scaffold during construction, ladders for entrance to the bins after construction and eventual support for overhead conveyors or other superstructions. The entire construction is so extremely simple, its dimensions so easily determined by simple calculations and the entire construction so practical from an engineering standpoint, that the grain storehouses of the world must soon become constructed according to this system. Progressive elevator men of the twentieth century can afford to build no other.

Before closing I will repeat some of the principal advantages of Monier constructions. They are:

1. Durability--will last centuries.
2. Absolutely fireproof.
3 Maximum carrying capacity, with minimum weight of structure.
4. Resistance against shocks or vibrations.
5. Economy of space.
6. Saving in tie rods and anchor rods.
7. Rapid construction.
8. Cleanliness; absence of organic matter in materials.
9. Cheapness.
10. No expense for maintenance.
11. Absolutely air and water tight.
12. Dryness.
13. Adaptability to all possible forms or shapes.
14. Safety against thieves and enemies.
15. Reduction of insurance.

The photographs show the modus operandi of constructing the first Monier tank put up in Chicago. It was built in six hours, is 6 ft. in diameter, 10 ft. high, $3\frac{3}{4}$ inch thick walls. The horizontal rods are 3-16 in. in

diameter, and the vertical $\frac{1}{8}$ inch. It was built three years ago in the yard of the Illinois Steel Company, South Chicago, at which time a series of tests of the construction was executed under the supervision of Mr. L. Holmboe, Engineer of Constructions of the Illinois Steel Co.; Mr. L. Gasha, Mechanical Engineer, Illinois Steel Co.; Mr. John Jones, Superintendent Concrete Construction, Illinois Steel Co., and the writer.



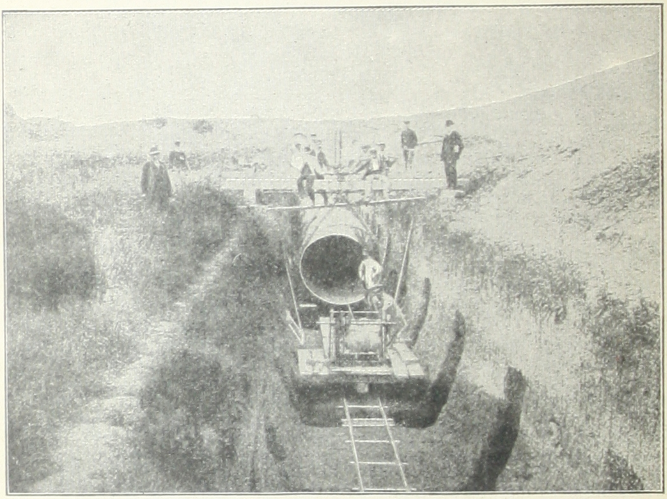
A-3. Cement Reservoir above the Irrigating Fields at Gennevilliers.

APPLICATION OF THE MONIER SYSTEM IN HYDRAULIC ENGINEERING.

Monier pipes for sewers or water conduits are either constructed in place by a continuous process or built at factories in about 10-ft. lengths. The pipes may be circular or oval and of any size. If they are not over 20 ins. in diameter they are provided with bells and sockets like common clay or cast iron pipes. In larger diameters, the pipe ends are placed on saddles and the joints covered with a wire netting of about 1 in. mesh upon which cement mortar is smeared with a trowel to a thickness of 1 in. or more and the width of about 5 ins. Saddles and wire nettings are delivered with the pipes from the factory. In the construction of sewers in Offenbach, Germany, about 3,000 ft. of 5-ft. sewers were laid on the continuous system in 1884, and in 1892 25,000 ft. were laid by the more modern system of building the pipe at the factory and laying them on saddles as just described.

The carrying rods in pipes are, of course, around the circumference while the distributing rods run longitudinally. Pipes subjected to internal pressure have the carrying rods near the exterior surface, while in pipes with external pressure the rods are located nearer the inner surface. Regarding the strength of Monier pipes it has been proved that while they weigh less than common vitrified clay sewer pipe, they have about six times the strength of the same. In the construction of large reservoirs for water, the carrying rods are located horizontally and the distributing rods vertically. If the reservoirs are not exposed to shocks or heavy vibra-

tions, it is customary to place the distributing rods at a distance from four to six times the space between the carrying rods. The thickness of the walls is reduced to remarkably small figures. Large reservoirs are built of a thickness from 2 to 3 ins. at the top and 4 to 5 ins. at the bottom. A reservoir at Leipzig water works contains about 2,000,000 gals. In France there



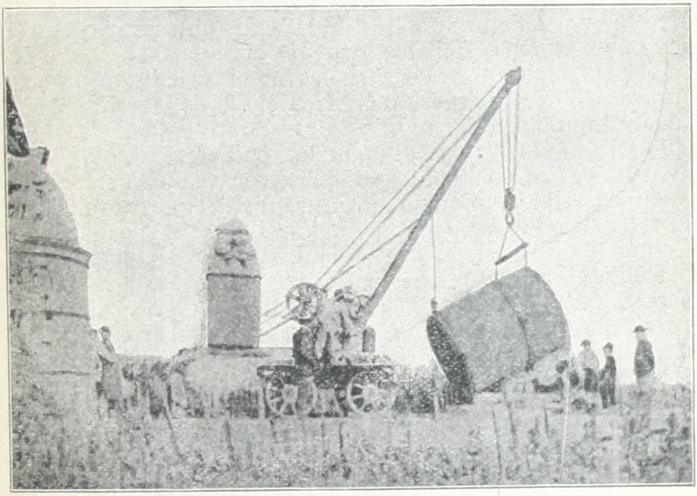
A-1. Laying Concrete Sewer Pipe.

are over 1,000 water reservoirs built of Monier construction.

It will readily be seen that Monier construction may be applied to good advantage as flumes and tail races in turbine construction as, for instance, in a large factory of arms at Steyr, in Austria, where there are two large Monier turbine constructions with 1,500 ft. of flumes and tail races. One of the most permanent

constructions in fortified concrete is the new intercepting sewer system in Paris, France, just finished, and from which the accompanying cuts are taken, numbered from A-1 to A-7 inclusive.

To show how universal the construction of Monier pipes and sewers is in Germany, I add a list of some of the pipe contracts executed by G. A. Wayss of Berlin:



A 2. Lowering Section of Concrete Sewer Pipe.

Offenbach a. Main, about 10,000 lin. ft. of circular Monier pipes for sewers from 12 ins. to 22 ins. in diameter elliptical pipes from 20 ins. x 30 to 40 ins. x 60 ins. in the clear.

Koenigsberg, elliptic sewers 20 in. x 32 ins. to 40 ins. x 75 ins., about 3,300 ft.

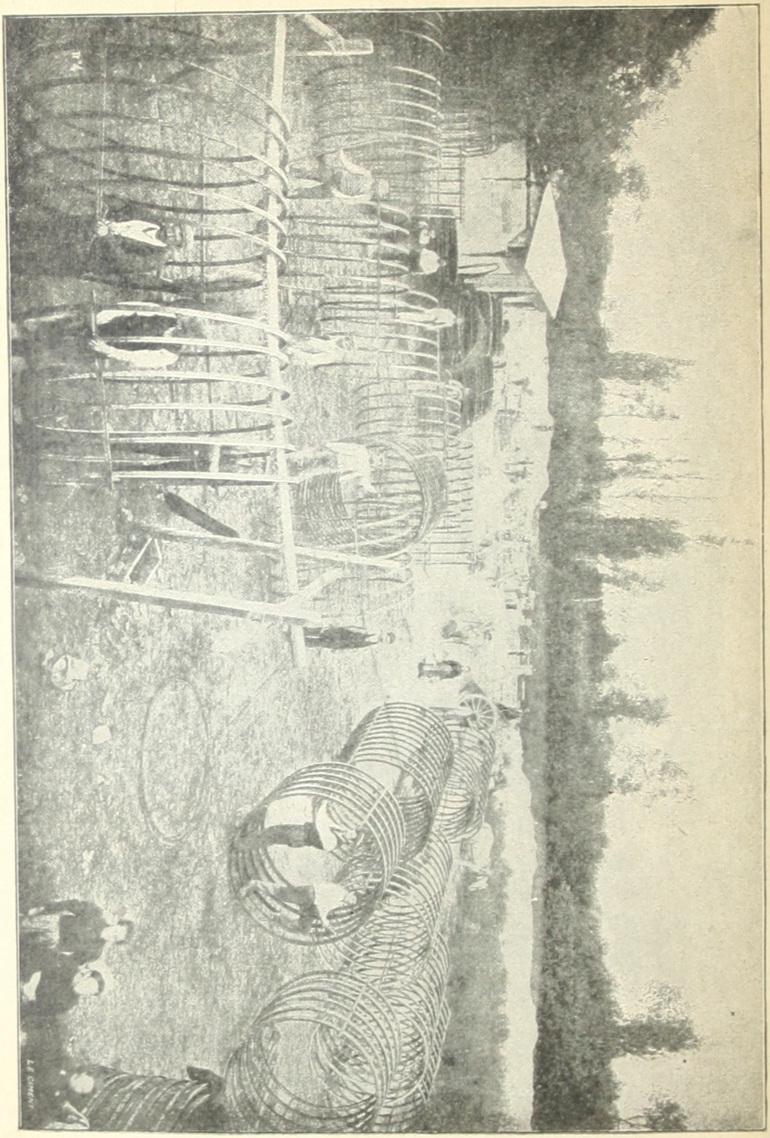
Kaiserslautern, 3,300 ft. of sewer pipe of different dimensions.

Breslau, 3,300 ft. of 32 in. sewer pipe.

Muelhausen, 3.300 ft. of 32 ft. elliptic sewer pipe 24 x 35 ins.

Bremen, 5,000 ft. of sewer pipe 35 ins. x 52 ins.

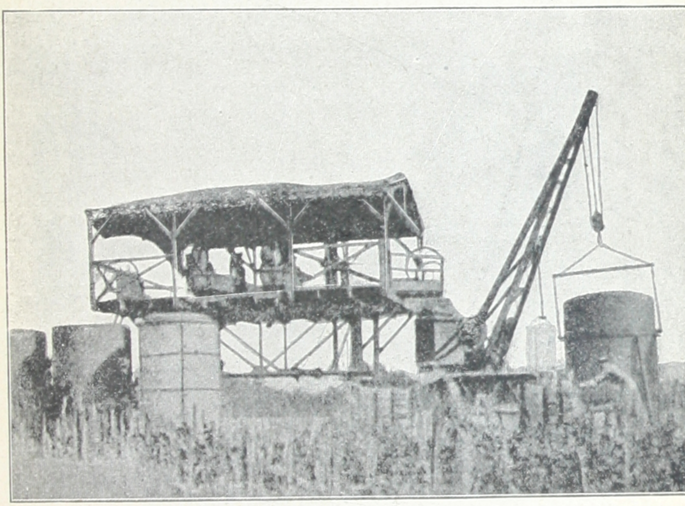
Flensberg, 3,300 ft. of sewer pipe.



Venezuela, South America, 33,000 ft. of Monier pipe, circular and elliptic, for railway construction.

And besides Monier pipes of all descriptions in the following towns:

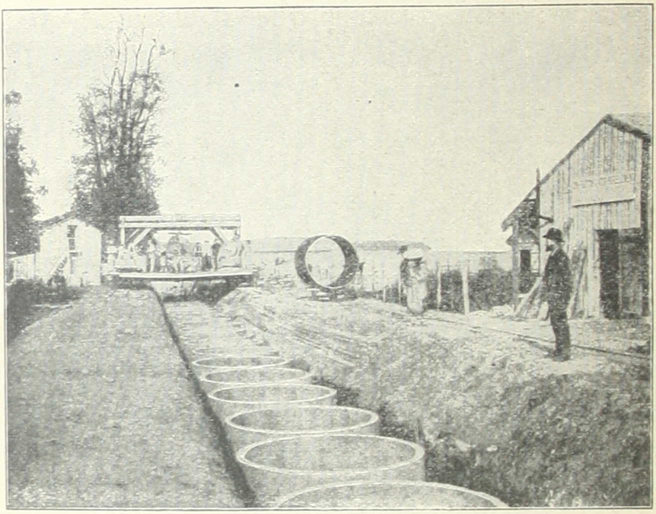
Ederswalde	Spandau	Falkenberg
Altona	Potsdam	Pr. Eulau
Perleberg	Berlin	Grottkau
Luneburg	Bromberg	Neustadt O. Schl.
Frankfurt, a.d. Oder	Coln a. Rh.	Oehls



A-4. Raising Concrete Pipe.

Magdeburg	Sommerfeld	Rixdorf-Berlin
Kottbus	Sprau	Diedesfeld
Breslau	Liegnitz	Zuethen
Inowrazlaw	Neumarkt	Oppeln i. Schl.
Brieg	Clausford	Posen
Strehlen	Kneiting i. Bayern	Tarnowitz
Waldenburg	Strassburg i. Els.	Sagan
Glatz	Gassen	Ostrowo

Karlshruhe
Altenstrig i. Bayern
Budapest
Traunstein
Napoleonsinsel
Strassburg i. Els.
Neumarkt i. Bayern
Ludwigshafen
Munchen
Briesen
Wilhelmshaven
Frankenthal
Osterode am Harz
Zweibrucken
Andreasberg a. Harz
Steyr
Bernburg i. Anhalt
Wismar i. Mecklbg
Greifshagen
Neckarau bei Mannheim
Achonebeck a. d. Elbe
Waldhoff
Gr. Lichterfelde bei Berlin
Andendung gekomnen



A-5 Concrete Pipe Yard.

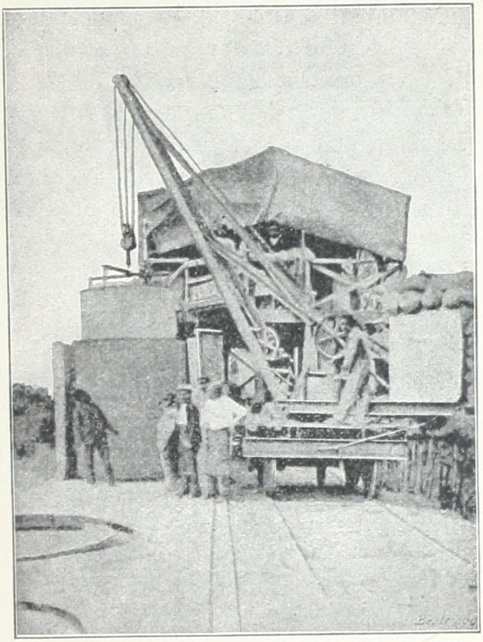
Haselhorst bei Spandau
Freienwalde a. d. Oder
Furstenwalde a. d. Spree
Ludwigshafen a Rhein.

Below follows a list of water basins, reservoirs, filters and tail races, executed in Monier construction:

Charlottenburg Water Works, a double reservoir of 70,000 cu. ft. contents.

Leipzig, a water stand pipe of 300,000 cu. ft. contents, built in 1885.

Stralsund, a filter chamber of 52,000 sq. ft. surface one-half being open, the other one-half covered with Monier arches from 21 to 26 ft. span, all being surmounted by a double reservoir of 100,000 cu. ft. contents, supported on Monier arches of 33 ft. span, built in 1892.



A-6. Drawing the Mandril from Concrete Pipe.

Haselhorst bei. Spandau, gasometer reservoir in Monier construction 24 ft. in diameter and 13 ft. high.

Harburg tar cistern 26,000 cu. ft. contents, resting on Monier arches of 15 ft. span.

Charlottenburg reservoir tower, with four large reservoirs in Monier constructions of 23 ft. in diameter and 10 ft. high.

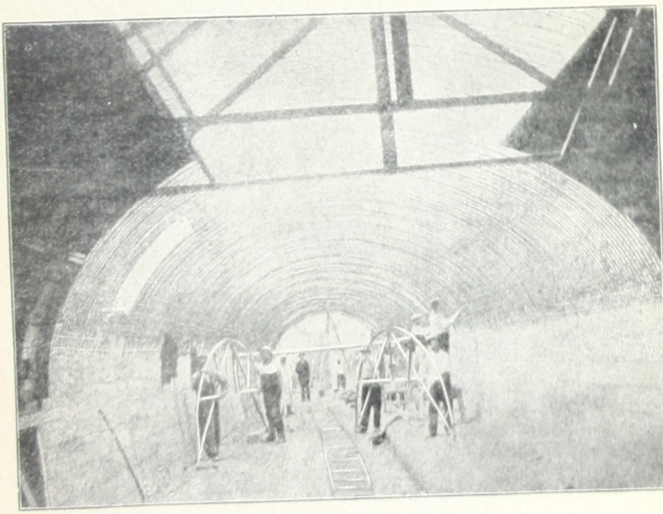
APPLICATION OF MONIER SYSTEM IN BRIDGE CONSTRUCTION.

Abroad in a large number of instances, bridges have been built entirely in Monier construction, using no other material than the steel rods and the concrete. This has also been done to some extent in this country where the Melan and the Ransome systems have in a few instances been used and with good success, but the most important field for the use of the Monier system in bridge construction at this time would be protecting our present system of steel bridge and viaducts—in which the materials principally are iron and steel—from oxidation or other influences, such as fumes of locomotives, etc. At the present day, when grade crossings are being abolished, sub-ways built and viaducts erected in nearly every city of prominence, a large expense is incurred yearly in scraping and painting the iron so as to prevent its destruction. It has been tried to cover the present steel construction with tile such as the Illinois Central viaducts at Van Buren street in Chicago. In Buffalo the underside of some of the viaducts are covered with matched wooden ceiling well painted. The by-pass of the Chicago river has cement mortar plastered on expanded metal to preserve the girders and common concrete arches between the girders without Monier.

Now, how much simpler the Monier construction makes matters. Buckle plates and bent plates may be done away with entirely, the span between the girders increased very considerably and Monier arches carried between the same, supported on angle iron shelves near

the top flange. The lower part of the girders are covered by Monier plates attached in a very simple manner, and the result is that not an inch of iron is exposed on the entire construction, air and fumes are excluded and the cost of maintenance reduced to a minimum.

I shall not go into further details in this branch of the application of the Monier system, but will be

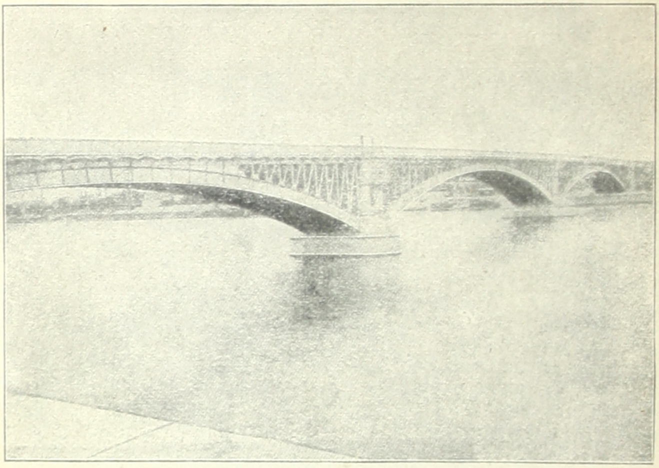


A 7. Monier Gallery for High Pressure Conduits.

pleased at any time to show photographs and plans, and explain the matter more fully to any one interested.

As representative of the patentee for Monier construction in the United States, I have a large number of photographs with testimonials and descriptions of the great and varied uses of this system, by the most eminent engineers in Europe, based upon actual experience, which I shall be pleased, at any time, to

show to whoever is interested in the matter. The Monier constructions have a great and interesting future, particularly in the United States, where rapid construction with minimum material and cost is always sought, to produce maximum results. It can be a



A-8 Aqueduct Carrying Monier Gallery Shown in A-7.

matter of only a short time until constructions under the system of Monier will be fully as common as in Europe. The system is sure to be extended and perfected to meet the requirements of other uses as have other systems brought here from abroad.